

CRUDE OIL DEGRADATION IN AN ARTIFICIAL POLLUTED SOIL

DEGRADAREA ȚIȚEIULUI ÎNTR-UN SOL POLUAT ARTIFICIAL

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Abstract. *Crude oil is both the principle source of energy for man and an important environmental pollutant. Bioremediation is becoming the technology of choice for the remediation of many contaminated/polluted soils, particularly with petroleum hydrocarbons. This paper presents the results obtained in the second year of bioremediation in the soil polluted with 5% and 10% crude oil, treated with a natural biodegradable product and bacterial inoculum. The plant use in the experiment is maize. The aim of this study was to examine the effects of the natural biodegradable product and bacterial inoculum on the degradation of crude oil hydrocarbons and on plant growth.*

Key word: degradation, crude oil, polluted soil

Rezumat. *Țițeiul este principala sursă de energie, dar în același timp un important poluator al mediului înconjurător. Bioremedierea a devenit cea mai bună tehnologie de remediere a solurilor contaminate/poluate, mai ales cu hidrocarburi din petrol. Lucrarea prezintă rezultatele obținute în cadrul celui de-al doilea an experimental de bioremediere a solului poluat cu 5% și 10% țiței, tratat cu un produs biodegradabil natural și inocul bacterian. Planta utilizată în cadrul experimentului este porumbul. Scopul studiului este acela de a urmări efectele produsului natural biodegradabil și al inoculului bacterian asupra degradării hidrocarburilor din țiței și a dezvoltării plantei.*

Cuvinte cheie: degradare, țiței, sol poluat

INTRODUCTION

Accidental spills of crude oil and its refined products occur on a frequent basis during routine operations of extraction, transportation, storage, refining and distribution.

Bioremediation was tested for the first time in 1989, when 40,9 millions litres crude oil (Exxon Valdez incident) polluted 2200 km costal area in the Prince William Sound, Alaska. It is considered one of the most devastating human-caused environmental disasters ever to occur at sea. As significant as the Exxon Valdez spill was, it ranks well down on the list of the world's largest crude oil spills in terms of volume released. Exxon had to pay 900 millions \$ and contact Environmental Protection Agency (EPA) to find an immediately and efficient solution. The researchers found a large taxonomic variety in microorganisms and a good aeration of soil and decided to use the bioremediation method by nutrients addition (azote, phosphorous) to increase biodegradability rate. The decontamination was a real success and was achieved in short time.

Bioremediation of crude oil polluted soils (decontamination by using microorganisms) is an efficient solution from economically point of view compared to the physical and chemical methods.

Bioremediation strategies are based on the application of various methodologies to increase the rate or extent of the biodegradation process. Biodegradation as a natural process may proceed slowly, depending on the type of oil. The success of oil spill bioremediation depends on our ability to optimize various physical, chemical, and biological conditions in the contaminated environment. The most important requirement is the presence of microorganisms with the appropriate metabolic capabilities.

MATERIAL AND METHODS

It has been achieved an experiment in Green House. The soil used in the experiment was cambic chernozem with a pH value by 8,09, organic matter content value by 5,155%, organic carbon content by 2,99%, azote content by 0,279% and a ratio carbon/azote (C/N) by 12,5.

The experiment has 11 experimental variants with soil polluted 5% and 10% crude oil, treated with 50g, 100g and 200g ECOSOL/20 kg polluted soil, inoculated and uninoculated with bacteria selected according to the following experimental scheme:

- ✓ V₁, control (unpolluted soil);
- ✓ V₂, polluted soil with 5% crude oil;
- ✓ V₃, polluted soil with 10% crude oil;
- ✓ V₄, polluted soil with 5% crude oil + 50 g ECOSOL;
- ✓ V₅, polluted soil with 5% crude oil + 50 g ECOSOL + bacterial inoculum;
- ✓ V₆, polluted soil with 5% crude oil + 100 g ECOSOL;
- ✓ V₇, polluted soil with 5% crude oil + 100 g ECOSOL + bacterial inoculum;
- ✓ V₈, polluted soil with 10% crude oil + 100 g ECOSOL;
- ✓ V₉, polluted soil with 10% crude oil + 100 g ECOSOL + bacterial inoculum;
- ✓ V₁₀, polluted soil with 10% crude oil + 200 g ECOSOL;
- ✓ V₁₁, polluted soil with 10% crude oil + 200 g ECOSOL + bacterial inoculum.

In the first experimental year was observed an increase of biodegradability rate in accordance with the applied treatment, so the experiment continued.

For determining the total petroleum hydrocarbons concentration from soil samples was used gravimetric method. The samples was submit to a solide-liquid extraction in organic solvent by using Soxhlet device. The minimum time for extraction is 4 hours in function with sample content in petroleum hydrocarbons.

RESULTS AND DISCUSSIONS

The soil polluted with 5% and 10% crude oil, treated with different quantities of natural product, inoculated and uninoculated with bacteria inoculum determined a decrease of total petroleum hydrocarbons concentration in accordance with the applied treatment.

The results obtained in the second experimental year shows that the biodegradation processes take time according to the existing literature data. A decrease was recorded in time and this agrees with the observation existing in scientific literature.

Each value for total petroleum hydrocarbons concentration represents the mean of 3 replicates.

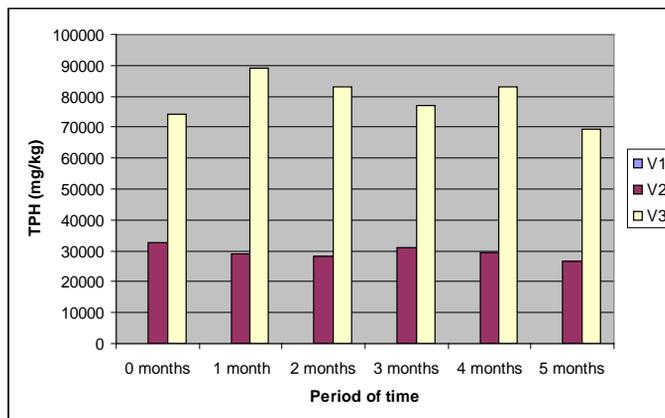


Fig.1. The evolution of total petroleum hydrocarbons (TPH) concentration in unpolluted soil, polluted soil with 5% crude oil and polluted soil with 10% crude oil (V_1, V_2, V_3)

The evolution of total petroleum hydrocarbons concentration with time in experimental variant V_1 - unpolluted soil, V_2 - polluted soil with 5% crude oil and V_3 - polluted soil with 10% crude oil is presented in figure 1. The figure shows that total petroleum hydrocarbons values were higher on experimental variants with polluted soils compared to the control suggesting the presence of crude oil.

The total petroleum hydrocarbons concentration decreases in time with 19%, respectively 6% in the polluted soil with 5%, respectively 10% crude oil.

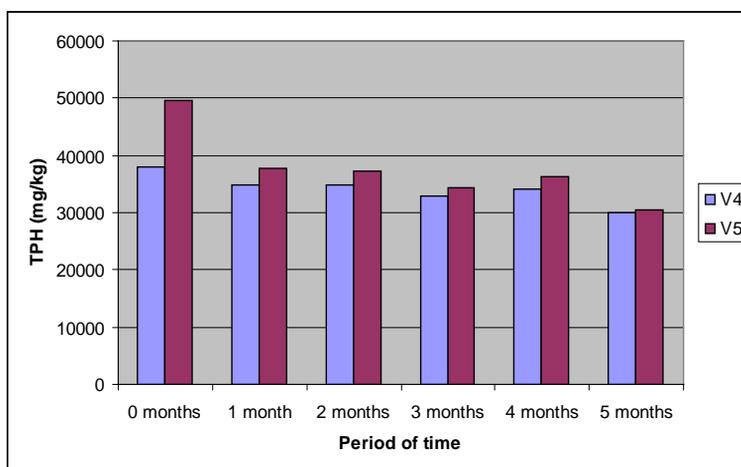


Fig. 2. The evolution of total petroleum hydrocarbons (TPH) concentration in the polluted soil with 5% crude oil conditioned with 50 g ECOSOL/20 kg polluted soil (V_4 and V_5)

The evolution of total petroleum hydrocarbons concentration in the polluted soil with 5% crude oil conditioned with 50 g ECOSOL/20 kg polluted soil is presented in figure 2. The polluted soil with 5% crude oil conditioned with 50 g ECOSOL/20 kg polluted soil presented a total petroleum hydrocarbons decrease in time with 20% in the case of V₄ experimental variant and with 38% in case of inoculated variant V₅ comparatively with the untreated polluted soil where the decrease was by 19%.

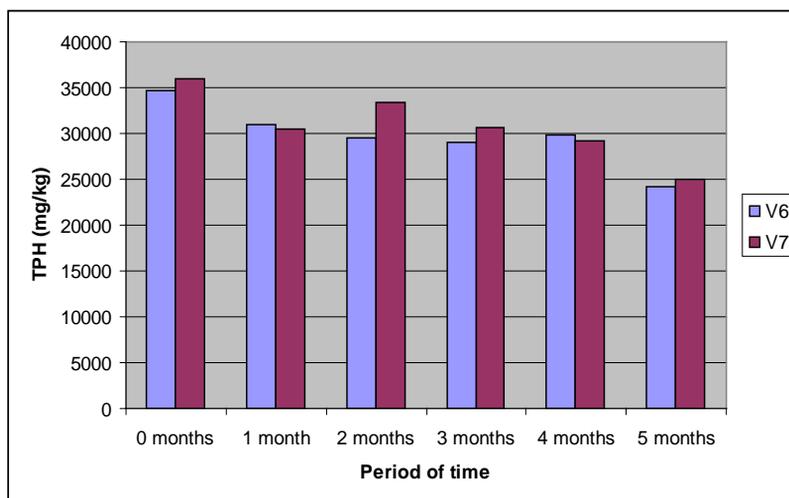


Fig. 3. The evolution of total petroleum hydrocarbons (TPH) concentration in the polluted soil with 5% crude oil conditioned with 100 g ECOSOL/20 kg polluted soil (V₆ and V₇)

The evolution of total petroleum hydrocarbons concentration in the polluted soil with 5% crude oil conditioned with 100 g ECOSOL/20 kg polluted soil is presented in figure 3. The total petroleum hydrocarbons concentration decreases with 30% in V₆ experimental variant and with 31% in the inoculated variant V₇.

If there are analysed the experimental variants polluted with 5% crude oil, conditioned with 50 g ECOSOL/20 kg polluted soil, respectively 100 g ECOSOL/20 kg polluted soil, the decrease were by 20%, respectively 30%. In the experimental variants polluted with 5% crude oil, inoculated with bacteria, conditioned with 50 g ECOSOL/20 kg polluted soil, respectively 100 g ECOSOL/20 kg polluted soil, the decrease were by 38%, respectively 31%.

As a preliminary conclusion, the experimental variant recommended to remediate a polluted soil with 5% crude oil could be the one treated with 100 g ECOSOL/20 kg polluted soil and bacterial inoculum.

The evolution of total petroleum hydrocarbons concentration in the polluted soil with 10% crude oil conditioned with 100 g ECOSOL/20 kg polluted soil is presented in figure 4.

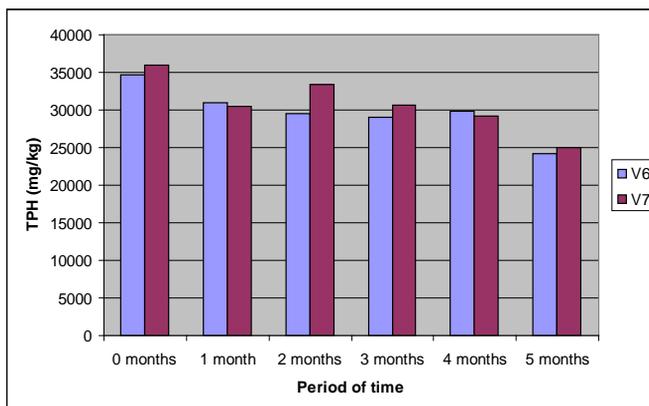


Fig. 4. The evolution of total petroleum hydrocarbons (TPH) concentration in the polluted soil with 10% crude oil conditioned with 100 g ECOSOL/20 kg polluted soil (V₈ and V₉)

As it can be observed, the polluted soil with 10% crude oil conditioned with 100 g ECOSOL/20 kg polluted soil presented a total petroleum hydrocarbons decrease in time with 12% in the case of V₈ experimental variant and with 20% in case of inoculated variant V₉, comparatively with the untreated polluted soil where the decrease was by 6%.

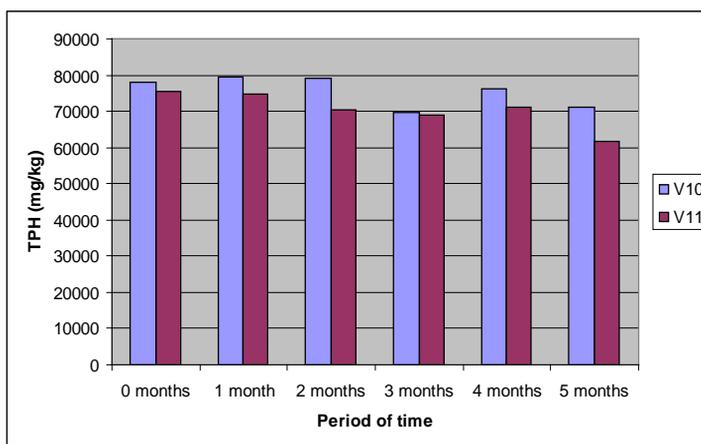


Fig. 5. The evolution of total petroleum hydrocarbons (TPH) concentration in the polluted soil with 10% crude oil conditioned with 200 g ECOSOL/20 kg polluted soil (V₁₀ and V₁₁)

The evolution of total petroleum hydrocarbons concentration in the polluted soil with 10% crude oil conditioned with 200 g ECOSOL/20 kg polluted soil is presented in figure 5. The total petroleum hydrocarbons concentration decreases with 10% in V₁₀ experimental variant and with 18% in the inoculated variant V₁₁.

In the experimental variants polluted with 10% crude oil, conditioned with 100 g ECOSOL, respectively 200 g ECOSOL/20 kg polluted soil, the decrease were by 12%, respectively 10%. In the experimental variants polluted with 10%

crude oil, inoculated with bacteria, conditioned with 100 g ECOSOL/20 kg polluted soil, respectively 200 g ECOSOL/20 kg polluted soil, the decrease were by 20%, respectively 18%.

As a preliminary conclusion, the experimental variant recommended to remediate a polluted soil with 10% crude oil could be the one treated with 200 g ECOSOL/20 kg polluted soil and bacterial inoculum to increase the biodegradability rate.

CONCLUSIONS

The experimental study leads to the following preliminary conclusions:

- ✓ To remediate a soil polluted with 10% crude oil is recommended the treatment with 100 g ECOSOL/20 kg polluted soil and bacterial inoculum to increase the biodegradability rate.
- ✓ To remediate a soil polluted with 10% crude oil is recommended the treatment with 200 g ECOSOL/20 kg polluted soil and bacterial inoculum to increase the biodegradability rate.
- ✓ The results obtained in the second experimental year leads to the conclusion that the treatment of the crude oil polluted soil with natural product and bacterial inoculum determined a decrease of total petroleum concentration in time.
- ✓ The reduction of pollution degree in experimental variants is due to the intensification of biodegradation processes and the establishment of a favorable equilibrium from microbiological point of view.

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